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ABSTRACT

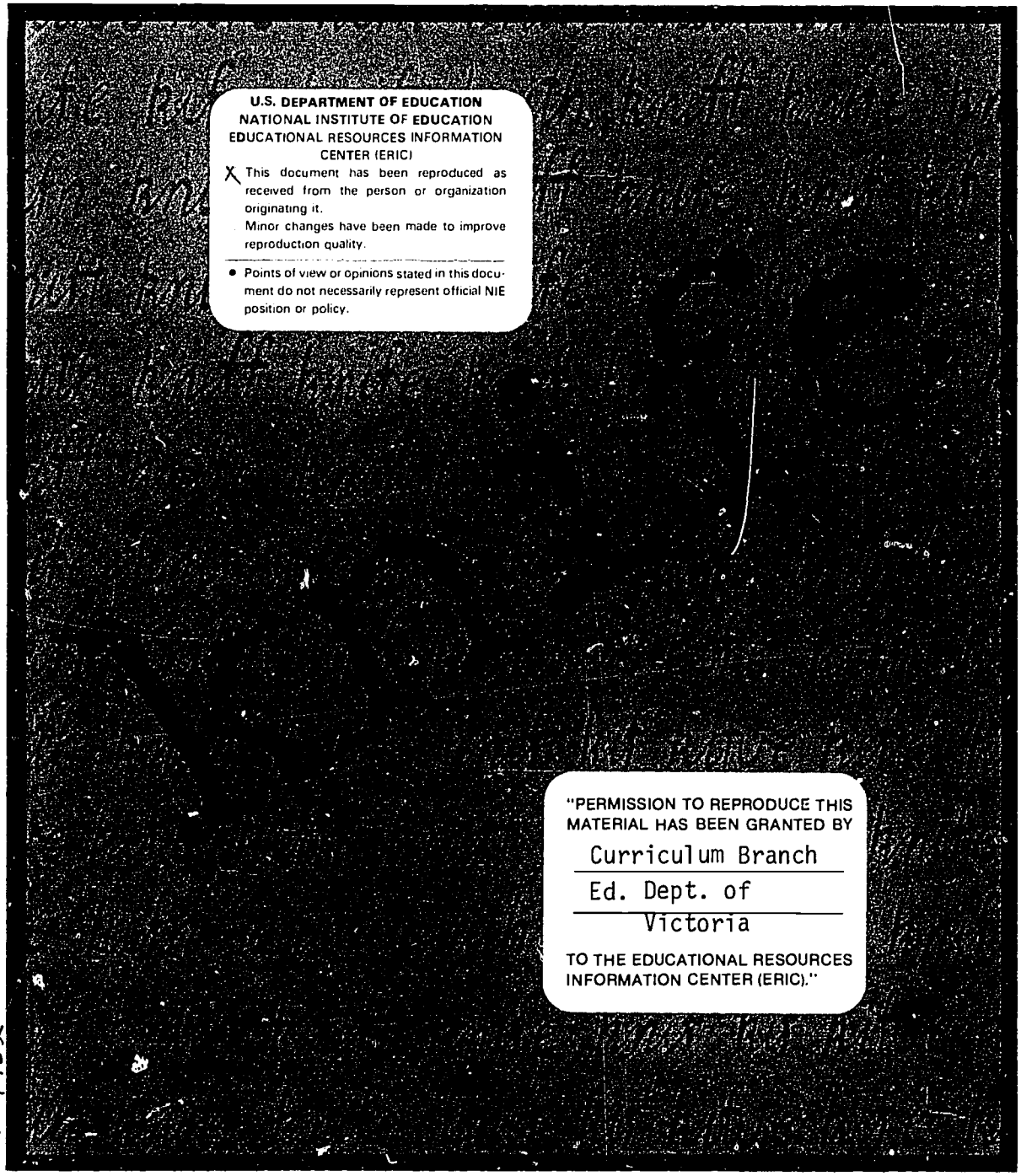
A study investigated the concept of visual memory and its relationship to the spelling process by examining the attempts of a group of Australian elementary school children to spell a selection of words containing silent consonants. Subjects, 360 second, third, and fourth grade students divided into three spelling ability groups, were given 20 words with silent consonants chosen from "The American Heritage Word Frequency Book" as a spelling task. The results indicated a statistically significant correlation between word frequency and correctness in spelling for each age group. Analysis of incorrect attempts indicated student knowledge of acceptable orthographic patterns and, in some cases, knowledge of the word's visual structure. Incorrect attempts contained initial silent consonants more often than medial or final silent consonants. The data supported the notion of developing a visual strategy for dealing with English orthography, acquired through experience with both written and oral language, and involving a knowledge of acceptable orthographic patterns. (Copies of the spelling tests used in the study are appended, with analyses.) (HTH)

RESEARCH REPORT 1/83

LEARNING TO SPELL:
THE ROLE OF VISUAL MEMORY

SPELLING PROCESS PROJECT TEAM

HEATHER FEHRING



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RESEARCH REPORT 1/83

LEARNING TO SPELL:

The Role of Visual Memory

by
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Spelling Process Project Team
Curriculum Branch: Research
and Development

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ABSTRACT

This study examined the concept of visual memory and its relationship to the spelling process. This relationship was investigated by examining the attempts of a group of Year 2, 3 and 4 children to spell a selection of words containing silent consonants.

Analysis of the data showed a statistically significant correlation between the measure of word frequency and the number of words spelled correctly for each of the Year levels 2, 3 and 4. The data showed that high frequency silent consonant words were spelled correctly more often than low frequency words. Analysis of the incorrect attempts at the silent consonant words revealed data which indicated knowledge of acceptable orthographic patterns in English, and, in some cases, a knowledge of the visual structure of the word.

There was some evidence to show that beginning silent consonants were produced more frequently in incorrect attempts than were medial or final consonants.

The data in this study supports the notion of the development of a visual strategy for dealing with English orthography. However, this strategy is not necessarily used in isolation, but as part of a combination of strategies acquired through experience with both written and oral language, and it involves a knowledge of acceptable orthographic patterns.

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Introduction

Over the past decade or so there has been increased interest and speculation as to the role of visual memory in the spelling process. A literature search reveals references to visual memory such as the following:

There are children, especially those with limited oral English background, who spell perfectly because of visual memories of the design of words.
(Groff, 1969, p.209)

Some types of spelling error are purely visual in character, and result from a confusion between letters of similar shape, from a mistake in left-to-right sequencing, or from a weakness in visual memory for letter-clusters and whole words.
(Moseley, 1974, p.19)

Sight is our preferred sense. We use sight to check the correctness or incorrectness of our spelling. In other words, spelling is a visual and not an auditory skill.
(Cripps, 1975, p.126)

Finally, the speller must check the graphic form with a recalled visual image.
(Lesiak et al., 1979, p.491)

There would appear to be certain face validity in the argument for the visual memory function in spelling. The work of Hanna, Hanna, Hodges and Rudorf (1966), and Simon & Simon (1973) illustrates that a total reliance on a phonemic strategy when it comes to spelling a word would be inadequate for writing the English language. The child who is attempting to spell the word sign may produce cine, sine or syne using a sound-symbol strategy. But this is not sufficient information to produce the correct spelling. Writers supporting a visual memory concept (Simon & Simon, 1973, Lesiak et al., 1979 and Cripps, 1975), would offer the explanation that during the production process, or following the attempt to spell the word, the child uses visualisation strategies to check that the word has been spelled correctly. This visualisation process is believed to occur with the spelling of words which do not follow a strict sound-symbol correspondence, such as once, scene, eye, two and people, and with the production of homophones such as stationery/stationary, bare/bear and read/red. In these cases, strategies other than sound-symbol matching must be employed to determine the correct selection and production of the required word. It is possible

that a visual memory of letter combinations or words is used to facilitate this process.

Visual memory would also appear to be necessary to explain the correct spelling of words with silent letters. The assumption is that people are able to produce the correct spelling of words such as lamb, dumb, knife, wriggle because they use stored visual information about such spellings. Marsh et al. (1980) make this assumption in their work on spelling strategy development. In illustrating the difference between sound-to-spelling and spelling-to-sound correspondences they come to the following conclusion:

> Sound-to-spelling correspondences are also generally less predictable than the spelling-to-sound correspondences in reading. For example the rules for pronouncing the letter k are quite predictable (i.e. k → /K/ except before n where it is silent). On the other hand, the spelling of the phoneme /K/ is variable and depends on the following vowel. In addition there is no simple way to predict whether or not a word begins with a silent letter k.
>
> The correct spelling of words with an initial silent k before n must depend primarily on visual memory.
> (Marsh et al., 1980, p.343)

However, the exact nature and functioning of visual memory has not been clarified. Henderson (1974) most appropriately summed up the issue when he wrote:

> We have also been told that good spellers have excellent visual memory. No doubt this was true. By looking carefully at a word they can tell you whether a word is spelled correctly or not. But what is excellent visual memory made of, pray tell? Are people equipped with little "Brownie" cameras in their heads? Obviously not! ...
> (Henderson, 1974, p.178)

Aspects of the concept visual memory are referred to in the literature by various terms - visual comparison, visual checking, visual recall, visual imagery and the process of visualisation. These terms do not always refer to the same function.

The general aim of this study was to investigate the concept of visual memory and examine its relationship to the spelling process.

Review of Research Literature

Research information pointing to a visual memory function in the spelling process comes from various fields of study. Evidence has been assumed directly from empirical studies investigating spelling strategies and studies of the spelling ability of deaf children. Evidence has also been extrapolated from theoretical models of memory and reading research studies. The following section of the paper examines these areas.

Visual Memory within a Theoretical Model of the Memory Process

The human memory is remarkably complex, and although researchers have studied it for many years, they are still only beginning to understand its complexities. Loftus and Loftus (1976) have defined memory simply as "some kind of repository in which facts (information) may be retained over some period of time" (p.1). This broad view naturally does not specify any of the attributes of memory such as the physiological properties,the encoding and decoding processes, the storage systems, or the retrieval mechanisms. Explanations of many of these memory processes have been confined to theoretical models.

The human organism, as we know it, receives stimuli from five basic sensory modalities - visual, auditory, tactile/kinaesthetic, olfactory and taste. Cognitive processing of the sensory stimuli produces the information which the individual operates on and involves retention of such information. In the case of reading and parts of the spelling process the stimuli are graphic representations of language. It is the graphic component that has lead to the assumption that visual perception and some kind of visual memory must be involved in both these processes. Jane Mackworth (1972) in her comprehensive paper on models of the reading process states: "All visual data that can be recognized must be stored in the brain ..." (p.708). It should be noted, however, that cues which initiate retrieval of such information may be a single or a complex interaction of the other sense modalities. The visual component of Mackworth's model is presented schematically in Figure 1 and details the systems which she considers to be involved in the reading process.

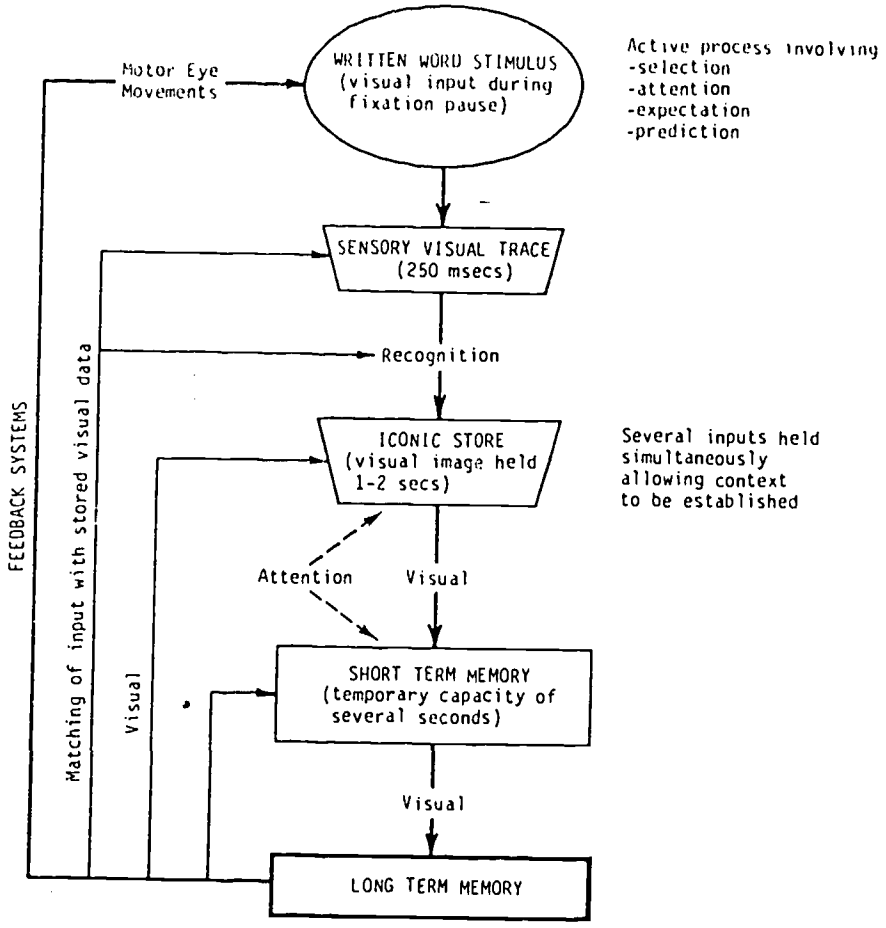

Figure 1 : Schematic Representation of the Visual Components of Mackworth's Model of the Reading Process (Mackworth, 1972; Geyer, 1972)

The following discussion relates to the visual components of the model shown in Figure 1. Physiologically the eyes are the visual receptor units, the external stimuli being visually registered via the retina and optic nerve. Visual processing begins with this very brief primary sensory visual trace. The visual input registered during the fixational pause of the eye movement sequence undergoes an active cognitive process involving selection, attention, expectancy and prediction. The resultant cognitive interpretation is transferred to memory. The cognitive processing of the sensory visual trace involves the extraction of information via parallel feedback mechanism from memory before the trace is destroyed by incoming data from the next fixation. It is hypothesised that recognition is

facilitated because the simultaneous nature of parallel processing enables a matching of visual input to memory traces which are a generalised visual record of the word and its components in Long Term Memory. Through recognition the visual input is stabilised and generalised, and becomes what is termed the iconic image. The Iconic Store, with a temporal capacity of from one to two seconds, is capable of holding several iconic images simultaneously, thus smoothing the further process of multiple discrete inputs and allowing context to be established. Processing of the iconic image involves matching of input with stored data via feedback mechanisms to the Short Term Memory and Long Term Memory. From the Iconic Store information is coded into Short Term Memory and Long Term Memory. Coding in memory is retained in some generalised visual form but may be recoded into a verbal form as well. Synthesis of all coded information occurs in the Long Term Memory. In the case of reading and spelling it may be the establishment of a lexicon, which is considered to be composed of abstract word units having several different facets or identities (Ehri, 1980). The visual memory component of the memory model should not be confused with the idea of a photographic image being stored, for as Nelson (1974) states it has never been demonstrated that knowledge of a word's spelling is held in memory as a "visual Gestalten" (p.36). The visual component must be thought of as a cognitive process involving information processed via the visual pathways.

Spelling within a Reading Research Perspective

A library could be filled with books about theoretical models of the reading process. However, in the last decade or so, with the development of the field of psycholinguistics, an almost universal belief is emerging that reading must be viewed within the context of a total language process perspective. Spelling, being an integral part of language, must also be viewed in this total context. Children already possess considerable linguistic competence with oral language when they begin learning to read and spell. They have learned that verbal utterances of sounds combined in various ways represent certain meanings. Children develop an awareness of the different meanings of such sentences as 'the boy hit the ball' and 'the ball hit the boy'. One of the major tasks facing children is how to use their existing knowledge of oral language to assist them in learning printed language. They must learn that specific graphic symbols combined in various ways also represent meaning. When reading and writing, children must learn the different meanings of such sentences as 'the girl read the book', and 'the girl's book was red'.

Central to this code learning is the brain. The brain organises the conceptual knowledge we acquire throughout life. One of the many functions of the human brain is the capacity to process and store language. In reading and related areas it is hypothesised that the brain organises what is termed a lexicon.

The lexicon is conceptualised as consisting of abstract word units having several different facets or identities. Ehri (1978, 1980) has formulated a 'Word Identity Amalgamation Theory' to explain printed word learning.

According to Ehri's theory every word has a phonological identity which consists of information about acoustic, articulatory and phonemic properties of the word. Every word has a syntactic identity specifying characteristic grammatical functions of the word in sentences (i.e. noun, verb). In addition, most words have a semantic identity, that is, a 'dictionary definition'. These three identities are thought to be acquired and known implicitly as a consequence of achieving competence with spoken language. In the process of learning to read and spell, another identity is added to the lexicon, the word's orthographic form (Ehri, 1980, p.313).

The orthographic identity consists of the correct graphemic combinations of a written word. A word, or an orthographic unit, bears a systematic relationship to the phonological properties of the word. Children approaching the task of reading and spelling already know the way many words are pronounced; one of their tasks is to assimilate a particular word's written form (orthographic structure), to its phonological structure. It is postulated that the integration of these four identities - orthographic structure, syntactic functions, semantic and phonological properties, form single representational units in lexical memory (Ehri, 1980, p.314).

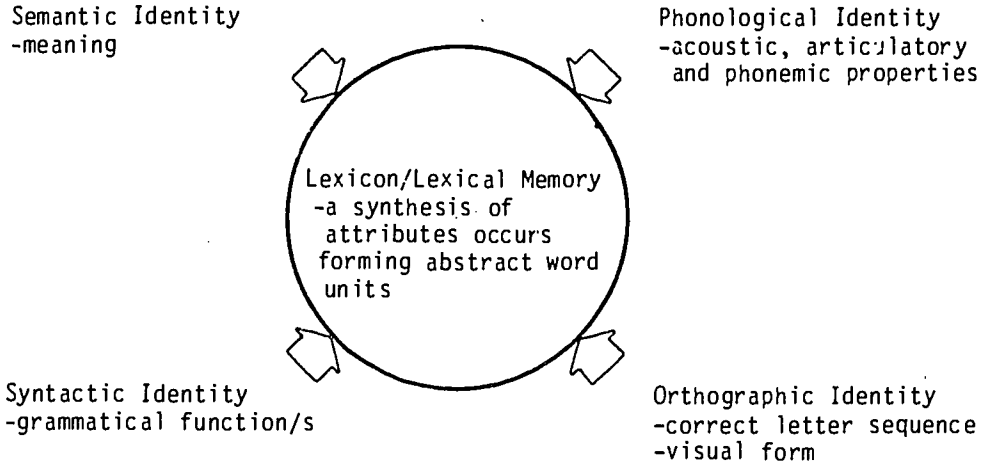

Figure 2 : Schematic Representation of Ehri's Word Identity Amalagamation Theory

In the process of a person becoming a fluent writer automatic muscle responses may develop and facilitate competency in spelling. Simon (1976) suggests that for words a person has written many times "a complete motor representation of the whole word, as distinct from its component letters, may be stored" (p.282). Personke and Yee write of the possibility of a similar function in their 'Theoretical Model of Spelling Behavior' (1966, 1968). They propose five distinct yet complementary channels of spelling behaviour. It is conceivably possible, according to Personke & Yee, that a direct link between memory and the written production may occur via a Kinesthetic Detour or Kinesthetic Bypass Channel (Mk) (1966). When the spelling of a word is so well known that it can be written without any apparent conscious thought they suggest that this (Mk) channel is utilised (Personke & Yee, 1968).

The way a word flows when it is written is referred to as motor memory in the Primary Schools Language Committee's document (1982). And Ehri (1980) refers to this notion as a motoric representation of a familiar word.

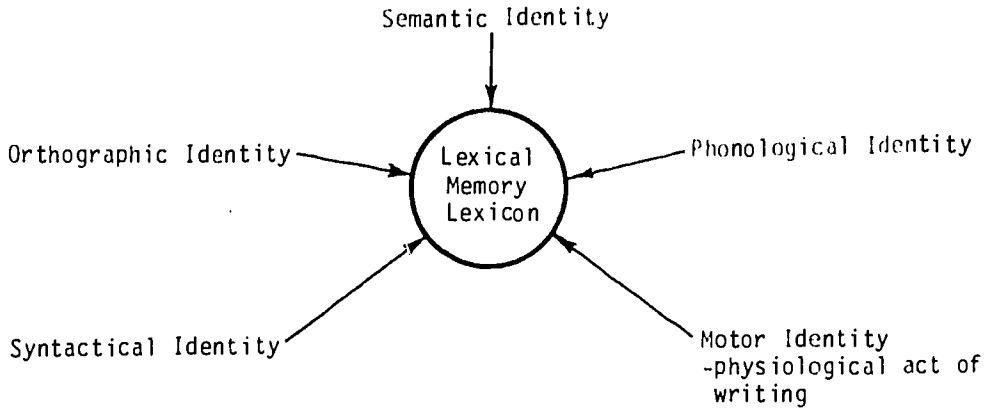

Figure 3 : Schematic Representation of the Integration of Information in the Lexicon

The process of learning to spell involves the acquisition of language knowledge in all the aforementioned areas. However, the research in this paper concentrates on an analysis of the orthographic identity and associated visual memory components of the spelling process. It is assumed that these interdependent components are important parts, but not the most important parts, of learning to spell. The purpose of the research was to investigate these particular components in the hope of shedding further light on their function in the spelling process.

Visual Memory and Spelling Strategies of the Deaf

Research into the cognitive abilities of deaf children is of relevance to the investigation of visual memory as a function involved in the spelling process. Since it is assumed that deaf children, specifically the congenitally deaf, could not possibly be utilising any form of auditory perception or acoustic memory, how these children learn to spell may be important in understanding strategies employed in spelling.

Several studies investigating the language abilities of deaf and hearing pupils have reported surprising results regarding the spelling capabilities of the deaf. (Gates & Chase, 1926; Templin, 1948; Hoemann et al., 1976; Markides, 1976; Dodd, 1980). Gates and Chase (1926) conducted several studies which investigated the spelling ability of deaf children. Their work in the area of word perception is particularly interesting. In one task, deaf and hearing children matched on number of misspelled words in a previous test, were asked to study the correct spellings for a period of time, without spelling them aloud or writing them down. All children were then required to attempt to spell the test words again. The deaf learned more during the one minute period of study than the hearing children.

> This superiority, under the conditions of the test, is in my judgment evidence that the deaf have a sharp perception for word-forms which is utilized in learning to spell.
> (Gates & Chase, 1926, p.297)

Two subsequent tests were administered. The first, a Word Selection Test, measured the speed and

accuracy with which a person can perceive an isolated word and immediately perceive it again in the midst of several other very similar words. The second, a Word Perception, Same-Different Test required a choice to be made between a pair of words on the basis of whether they were identical or not. The deaf and hearing children in the study were equated on reading ability. Once again, the deaf children demonstrated an "extraordinary word-perception ability" (Gates & Chase, 1926, p.299). The conclusion drawn from these studies was as follows:

> The deaf owe their remarkable spelling ability primarily to a peculiarly effective type of perceiving, of reacting visually to words.
> (Gates & Chase, 1926, p.299)

Gibson, Shurcliff and Yonas (1970) conducted experiments comparing the ability of deaf and hearing subjects to read and write pseudowords, that is, letter strings that are not real words. All the pseudowords constructed were monosyllables consisting of an initial consonant cluster, a vowel cluster, and a final consonant cluster. However, half the pseudowords were classified 'pronounceable', and constructed so that the initial consonant cluster had a single regular pronunciation in that position, as did the final cluster in its position, and the vowel cluster a regular pronunciation when preceded and followed by the selected consonant clusters. These pseudowords were classified as pronounceable words because the clusters had an invariant mapping from spelling-to-sound in these combinations. The other half of the pseudowords were classified as 'unpronounceable'. These pseudowords were constructed by reversing the initial and final consonant clusters of the pronounceable pseudowords. This effectively rendered their pronunciation unpredictable. For example, a pronounceable pseudoword was 'glurck', and its unpronounceable control combination was 'ckurgl'.

The results showed that deaf subjects made more errors than the hearing subjects on both pronounceable and unpronounceable pseudowords. The interesting point, however, was that the difference between the pronounceable and unpronounceable pseudowords was just as significant for the deaf as for the hearing.

> Whatever it is that facilitates reading the words in the pronounceable list seems to be operating equally well for them. Labelling the difference between the two lists "pronounceability" evidently served only to pull the wool over our eyes, for the deaf students had never heard the words pronounced.
> (Gibson, Shurcliff & Yonas, 1970, p.62)

In an attempt to analyse what accounted for the facilitation of the pronounceable pseudowords, multiple regression techniques were applied to the data. Spelling errors were the dependent variable and the predictor variables were word length, pronounceability rating and digram and trigram frequency measures. The results indicated that word length and pronounceability were the highest predictor variables. One of the frequency measures, the Mayzner digram count, was significant, and then only for the results of the deaf subjects. Gibson, Shurcliff and Yonas (1970) made the following concluding statements:

> These analyses seem to indicate that the pronounceability rating is actually measuring something more than sheer pronounceability, something that is reflected, but to a lesser degree, in the Mayzner digram count, and something that is potentially present in orthography alone, in that it facilitates the deaf at least as much as the hearing. It is our opinion that the rules in spelling account for the variance in these cases.
> (Gibson, Shurcliff & Yonas, 1970, p.67)

> An intelligent deaf reader does master and use the regular spelling patterns of the language in processing graphic material and is facilitated by their presence. The redundancy contributed by invariant mapping to speech sounds may well make it easier for the hearing child to pick up the common spelling patterns and regularities as he learns to read, but clearly it can be done without this.
> (Gibson, Shurcliff & Yonas, 1970, p.71)

Visual Memory and its Direct Relationship to the Spelling Process

Studies investigating visual memory appear to be divided between analyses involving theoretical models of the function of visual memory, and research studies which operationally define visual memory and proceed to show statistical relationships between visual memory and spelling achievement. From a theoretical perspective Hendrickson (1967) writes:

> Visualization is a process of visual comparison, visual recall (or memory), and visual imagery that allows one to see or experience again a previously seen or experienced object or event. It is the ability to "see" and know some thing or place, idea or concept of the past, to manipulate or view it from any angle and perspective.
> (Hendrickson, 1967, p.40)

Woodland (1975) writes in a similar vein when he states:

> Visualisation develops, is learned and is trainable. ... Theories of thinking propose that we think in terms of mental pictures of people, places, events and objects and use representative words of these items and of abstract ideas, and of thoughts.
> (Woodland, 1975, pp.5-6)

Both Hendrickson (1967) and Woodland (1975) propose that there is a developmental acquisition of the visualisation ability. The ability to make visual comparisons leads to the development of visual memory or visual recall which in turn is the foundation of visual imagery. Mastery of the visualisation process is considered by these writers to be an important function in spelling proficiency.* For, as Hendrickson writes:

> As the child learns to visualize he learns to look and observe. He learns to see, listen, and know more. He learns to see more in less time. He learns the visual ability of substituting symbols for experiences, and he learns symbol manipulation as a visual activity which, when adequately learned, produces a good writer, good reader, and a good speller. When he can visualize a word, he can spell it, regardless of how it sounds.
> (Hendrickson, 1967, p.42)

Researchers have attempted to investigate empirically the theoretical assumptions relating the influence of visual factors to the spelling process. However, the findings have been inconsistent and the studies need close analysis as to what was actually measured before conclusions can be drawn about the facilitatory functions of visual factors in the spelling process.

Visual discrimination has been found to bear a relationship to spelling ability (Nichols, 1949; Mason, 1961). Visual memory was found to be significantly related to spelling (Nichols, 1949; Hirshoren, 1969; Lesiak et al., 1979), but Bannatyne and Wichiarajote (1969) found only a low nonsignificant relationship. A close look at some of these studies opens up many interesting issues. Nichols (1949) correlated the results of a spelling achievement test with five tests involving "types of work related to spelling" (Nichols, 1949, p.154).

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* Obviously visual information is not an essential prerequisite for the development of spelling proficiency because of the spelling ability of the blind.

The five factors measured were labelled proofreading, word meaning, handwriting, visual discrimination and auditory discrimination. Visual discrimination was operationally defined by a test which consisted of three parts: i) selecting a word, which had been flashed for one second, from a row of five words similar in appearance; ii) same procedure as i) but the children had to wait five seconds before carrying out the instructions; iii) writing a flashed word from memory after a five second delay. Nichols concluded from the statistical results that:

> The positive correlation found between spelling achievement and each of the other subtests proved that these related factors condition achievement.
> (Nichols, 1949, p.158)

A positive correlation between two variables does not necessarily indicate that one variable has a causative influence on the other variable. Secondly, the visual discrimination subtest part iii), which purportedly measures visual memory, is of questionable validity. Other factors than visual memory may have affected the children's ability to reproduce the words in sub-test part iii), as, for example, language competence and/or prior knowledge of the spelling of the flashed word.

The relationship Hirshoren (1969) is reported to have found between visual memory and spelling is another interesting result. In his study Hirshoren (1969) correlated the Illinois Test of Psycholinguistic Abilities (I.T.P.A.) subtest scores of kindergarten children with their second grade achievement scores. The 1961 Experimental Edition of the Illinois Test of Psycholinguistic Abilities (McCarthy & Kirk, 1961)* contained a Visual-Motor Sequencing Test, the purpose of which was to "assess S's ability to reproduce a sequence of visual stimuli from memory" (McCarthy & Kirk, 1961, p.43). Each item in this test required the subjects to arrange certain numbers and types of chips in a given sequence. Each chip had a picture or geometrical shape on the face. The seven grade two achievement scores covered reading vocabulary and comprehension, arithmetic reasoning and fundamentals, mechanics of English, spelling and total achievement. Hirshoren's results (1969) showed that the "Visual Motor sequential subtest appeared to have significant predictive validity for school achievement two years later" (p.519). Hirshoren (1969) concluded that performance on the Visual Motor Sequential subtest was significantly related to spelling performance. However, it is difficult to see the relevance of the I.T.P.A. tasks to the actual spelling process. In particular, the significance of a positive correlation between a task involving the sequencing of chips displaying pictures or geometric shapes and spelling performance must be questioned.

Another study using the I.T.P.A. was that completed by Bannatyne and Wichiarajote (1969). This particular study used the revised 1968 I.T.P.A* (Kirk et al., 1968), and a written word spelling test. Bannatyne and Wichiarajote (1969) found a correlation of r= +.06 between their subjects' spelling achievement test and the visual sequencing sub-test of the I.T.P.A. They concluded:

> It would seem that visual sequencing of designs makes no contribution to written spelling.
> (Bannatyne & Wichiarajote, 1969, p.9)

Lesiak et al. (1979) investigated differences that distinguished good and poor spellers at the third and sixth grade levels on tasks which were selected to measure a variety of

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* In the 1968 revised edition of the Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy & Kirk, 1968) this sub-test was modified, and called Visual Sequential Memory (p.27) testing "short-term sequential memory" (p.12).

visual and auditory sub-skills. There were three tasks selected to tap visual discrimination and visual memory ability. The first was a Word Discrimination Test purporting to show how well a child uses length, internal design and external configuration in perceiving words. This test is designed to measure the ability to recognise a word as a word. The test consists of 96 items. Each item is composed of five groups of letters, only one of which is a word. The subject must select the group of letters which is a word. The other two tests which were concerned with visual memory, were the Primary and Intermediate versions of the Durrell Analysis of Reading Difficulty-Visual Memory for Words. In the Primary version a subject is shown a word for three seconds and then must select the word seen from a choice of five or seven alternatives. In the Intermediate version the subject must attempt to write from memory the previously exposed word. Lesiak et al. (1979) found a significant difference between good and poor third grade spellers on all three of the above mentioned tests. However, for the sixth grade children on these three tests only the Intermediate version of the Durrell Analysis of Reading Difficulty-Visual Memory for Words significantly discriminated between the good and poor spellers.

While the purpose of the study was to assess differences between good and poor spellers, the authors concluded that simple single skill tasks do not appear to be sufficient to discriminate among subjects. They suggested that researchers look at more complex learning processes to understand spelling success (Lesiak et al., 1979, p.494).

Some research studies have been specifically oriented towards investigating visual imagery and spelling behaviour. Walker (1974) investigated spelling errors and imagery ability. The author worked on the assumption that there are many words that do not conform to phonic rules, are difficult to learn by mnemonics or word-relationship methods, but seem to be learned as units. "In these cases particularly, visual memory could be an important component in spelling performance" (Walker, 1974, p.823). In this experiment a group of first year university students were classified into two groups-good visualisers and poor visualisers. These students had to attempt to spell 48 'demon' spelling words. Of these words, 24 were classified as words where the usual error was due to faulty pronunciation or inapplicable phonic generalisation - P errors. The other 24 words were classified as V errors - all errors other than those classified as P errors. Walker found that as he had "predicted, the superiority of good visualizers over poor visualizers was greater for V words than for P words" (Walker, 1974, p.825).

Radaker (1963) investigated the effect on children's spelling performance after the children had been trained to use visual imagery as a spelling strategy. (Table 1) The children in Radaker's experimental groups were given training in creating visual images of words that they were learning to spell. For example, they were encouraged to close their eyes and visualise an image of the word in large glossy black letters as though it were projected on an outdoor theatre screen. Various other suggestions of this type were used.

Following the two week training period it was suggested to the children in the Imagery Practice groups that they use this method for studying spelling. All children were pretested on Form M of the Stanford Achievement Test and post tested one year later on Form N of the same test. Radaker's results showed an increased spelling performance by the experimental groups as compared to the control group. Radaker (1963) interpreted his results as illustrating that visual imagery enhanced spelling performance. Several criticisms have been levelled at Radaker's study. Tenney (1980) criticised the study on the grounds

TABLE 1
Radaker's (1963) Study Design

	GROUPS		
	Control Group	I.P.2 (Imagery Practice 2 Group)	I.P.6 (Imagery Practice 6 Group)
Visual Imagery Practice over a 2 week period	None - Free play and social conversation	2 Sessions - 2 sessions of imagery practice 45 minutes each	6 Sessions - 6 sessions of imagery practice 45 minutes each

that it is difficult to separate the effects of visual imagery from the motivational factor of increased desire to learn to spell which the special training may have given the children. Sloboda (1980) criticised the study on the basis that there is no actual evidence to show use of imagery by the experimental groups of children. The improvement in spelling performance may have been due to concentrated attention to words rather than on the imagery as such. Also, there is no evidence to support the contention that the children actually used imagery in their spelling behaviour once the practice sessions were over.

Caban et al. (1978) also investigated mental imagery and spelling performance. These researchers investigated three approaches to spelling instruction, hypothesising that "Spelling words can be better learned and retained by using a mental imagery practice method than by using other spelling practice methods" (Caban et al., 1978, p.16). The mental imagery group were taught to attempt to form a mental picture of the word to be learned, reproduce the word on a special (easily erasable) slate with a copy of the word in view, check the reproduction, erase the word from the slate, and repeat this process five times for each word.

Following this process, the copy of the word was removed from view and the subject had to write, check and erase each word another five times. The spelling performance of the mental imagery group was then compared with the groups receiving the other two instructional methods (Caban et al., 1978, p.16 for full details of other instructional methods). Their results showed no statistically significant difference between the spelling performance of the three groups. However, the data did show that the mental imagery group scored higher than the other two groups on both post tests administered.

The criticisms levelled at this study are similar to those levelled at the Radaker (1963) study. The nature of the task used to denote mental imagery needs further refinement, and once again there is no direct evidence to show that the subjects actually utilised a visual imagery strategy to improve their spelling performance. Both the Radaker (1963) and Caban et al. (1978) studies need replication and/or design modifications for a major contribution to the area of visual imagery and spelling performance to be made.

Sloboda (1980) attempted to investigate the relationship of spelling behaviour and imagery from a new perspective. He sought to find a task involving spelling which would be helped by imagery but in which no specific instructions to image were given. He chose a task in which subjects heard a word and

were required to decide how many letters it contained. Based on evidence that visual imagery assists number estimation tasks (Sloboda, 1980, p.240), he assumed that visual imagery would assist th s particular spelling task. The words involved in this task were divided into what Sloboda termed 'phonemically transparent' or 'phonemically opaque' categories. The 'phonemically transparent' classification encompassed words with a simple correspondence between phonemes and graphemes, each phonemic element being represented by exactly one letter in the grapheme string, as for example in the word stands. The 'phonemically opaque' classification covered words where there is no one-to-one phoneme-grapheme correspondence: yellow. For spellers who use phonologically based representations for deriving spelling words the prediction was that it would be more difficult for them to count phonemically opaque than phonemically transparent words. Sloboda hypothesised "that visualisers should behave no differently to the two types of words, whereas the non-visualisers should perform less well on the opaque words" (Sloboda, 1980, p.241). However, Sloboda's results did not confirm his speculations. "Analysis of variance on the error distribution showed that the two groups of subjects did not differ significantly nor did performance on opaque words differ from that on transparent. ... Analysis of reaction times showed only one clearly significant effect. Longer words took longer to count" (Sloboda, 1980, p.243). Sloboda made the following comment about the results obtained in his initial analysis:

> There are many possible reasons for this lack of significant difference, and the least interesting, but most compelling is that the counting task simply does not respond to differences in spelling imagery and is therefore inappropriate as a technique for investigating the questions we are interested in.
> (Sloboda, 1980, p.244)

This observation could be generalised to several of the investigations of visual imagery and spelling performance. It would seem quite apparent that a more precise method of reflecting and measuring visual imagery is required in this field of investigation.

All the studies mentioned in this section have one common problem: that is, how to measure adequately the concepts of visual imagery and visual memory. The nature and content of the tasks designed have varied considerably, although the use of geometric designs has been most prevalent. Among the other factors which vary from study to study are the ages of the study participants, methods of task presentation, and mode of response, i.e. whether recognition or reproduction tasks are involved. The inconsistency of the results obtained raises many questions and makes it difficult to draw firm conclusions about the exact nature of visual memory and its relationship to the spelling process.

Before concluding this section of the paper, a mention must be made of the work of Margaret Peters (1967, 1970) and Charles Cripps (1975, 1978). These two writers are joint authors of a publication called Catchwords : Ideas for Teaching Spelling (1980, 2nd edition)*. Both writers support the notion that visual experience with words is vital to the spelling process.

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* This particular publication is the teachers' manual which accompanies a series of student activity booklets called Catchwords Blue, Red, Green, Yellow, Orange and Purple. The manual and the student material constitute the Catchwords spelling programme for children aged 6-11 years.

> "...how does the competent speller know whether the word is written correctly? (For example, 'allso', 'also'.) He knows by sight whether it looks right and this decision is dependent on visual reference. Sight is our preferred sense. We use sight to check the correctness or incorrectness of our spelling. Spelling is a visual and not an auditory skill". (Peters & Cripps, 1980, p.3)

It is the view of Peters & Cripps (1980) that words must be looked at with interest and "with intent and intention to reproduce" (p.3). They make the statement that good spellers look carefully at words and it is through this process that visual familiarity with letter patterns develops. Good spellers learn the probability of letters occurring together, which is also referred to as the knowledge of the serial or sequential probability of letter patterns in their language. In a task requiring recall of a particular spelling, competent spellers may utilise associations they have built up between structurally similar words. The Peters & Cripps (1980) interpretation of the spelling process incorporates a visual checking strategy. Once an attempt has been made at a particular spelling a writer checks the effort to see if it "looks right" (Peters & Cripps, 1980, p.10).

When the nature of the spelling process is considered, some of the Peters & Cripps (1980) assumptions appear to have credibility. However, only limited experimental evidence can be found to support these contentions, and Cripps, in particular, is lacking in published evidence for his views.

The visual checking strategy has been of interest to several other writers (Simon & Simon, 1973; Forster, 1976; Tenney, 1980; Morton, 1980; Jorm & Schoknecht, 1981).

Simon & Simon (1973) presented a theoretical model of the spelling process in which they proposed several channels along which the spelling of a word may be recalled. One of the channels involves a 'generate-and-test process' in which the speller first generates a written trial spelling using information based on stored phoneme-letter associations, and then tests this production against stored visual recognition information. If the visual match fails a further spelling may be generated. (Figure 4)

Jorm and Schoknecht (1981) have attempted to investigate empirically the word-recognition checking strategy assumed to be involved in the spelling process. These authors argue that if visual word-recognition checks have an important function in the spelling process, then written spelling

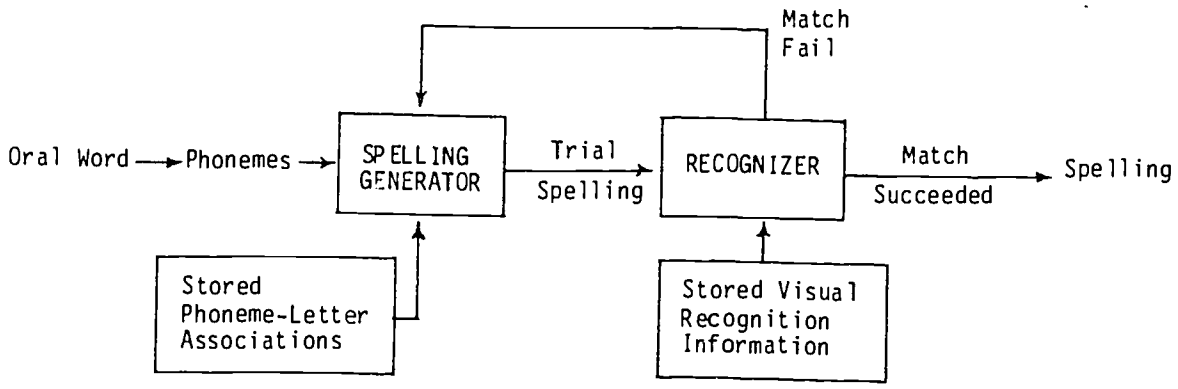

Figure 4 : Simon and Simon's Generate-and-Test Process (Simon & Simon, 1973, p.118)

performance should be superior to oral spelling performance. Although it is conceivable that visual imagery could assist oral spelling performance, it is argued that a written attempt at a word provides a superior comparison for the checking process. Their study involved 48 Grade 4 children and 48 Grade 6 children spelling 40 six letter words. The children were randomly assigned to one of the three experimental conditions: oral spelling, written spelling, and written spelling with explicit instructions to check for errors. The analysis of the number of correct spellings showed no statistically significant difference between the three spelling conditions.

> The results of Experiment 1 therefore failed to indicate an important role for word-recognition checks in children's spelling. Contrary to prediction, there was no difference in number of correct spellings as a function of whether the words were spelled orally or in writing or whether the children were explicitly instructed to check their spellings.
> (Jorm & Schoknecht, 1981, p.396)

A number of methodological limitations in the design of this study need to be considered. As Jorm & Schoknecht (1981) themselves point out, the group of children who were instructed to specifically check their spellings to see if they looked right, were told to do so after they had attempted all 40 words. It might prove interesting to repeat this experiment asking the children to check each spelling attempt a word at a time. After completing the 40 words and then beginning to check each attempt some children may have been unable to recall the word they had originally attempted to spell. A more powerful analytic technique may have been an analysis of variance repeated measures design where the same children participate in each experimental condition. A second and more refined investigation was carried out by Jorm & Schoknecht (1981). In this second experiment 28 children from Grades 4, 5 & 6 spelled 50 words 7-8 letters long. Of the 50 spelling words, half were chosen because they were considered regular, and half were considered irregular. "Irregular words are those which, by definition, cannot be spelled purely by phoneme - letter correspondence rules" (Jorm & Schoknecht, 1981, p.397). The authors argue that a word-recognition checking procedure should be of more use with irregular words than the so-called regular words. An attempt was also made to identify words which were within a "child's word-recognition lexicon (and were thus candidates for word-recognition checks when being spelled)" (Jorm & Schoknecht, 1981, p.397). Obviously words not in a child's word-recognition lexicon were not considered candidates for a word-recognition checking procedure.

The results of this second study are very interesting. Statistically significant main comparisons were found between : words in the children's word-recognition lexicon being spelled better than unknown words; regular words being spelled better than irregular words; and words being spelled better on the second test than on the first test. A statistically significant interaction effect was found between experimental condition and spelling test. This effect appeared to be due to there being an improvement in spelling performance from oral spelling to written spelling, but not from oral spelling to a second oral spelling. Jorm and Schoknecht (1981) argue that this finding shows that written spelling does produce better performance than oral spelling, an effect detected by the repeated measures design of the second experiment. However, the interesting result is that the improved performance from oral to written spelling does not appear to be related to the lexical status of the words

(i.e. whether or not the words are within a child's word-recognition lexicon) as was predicted. Jorm and Schoknecht (1981) interpret this result as a failure "to find evidence for word-recognition checking in spelling" (p.399).

Although neither of Jorm and Schoknecht's (1981) experiments gives support to the hypothesis that a visual checking strategy is fundamental to the spelling process, the concept cannot be rejected out of hand. As Jorm and Schoknecht state:

> ...the results cannot be taken to mean that visual word-recognition checks play no role in children's spelling. Such checks may occur so infrequently that they play only a very minor role and, consequently, their effects were not detected by the present experiments.
>
> (Jorm & Schoknecht, 1981, p.401)

The exploratory nature and the limited number of these experiments, along with the small numbers of children so far involved, certainly indicate the need for further investigation in this field.

In Summary

The theories reviewed here appear to indicate the existence of a cognitive process involving visual memory. Models of memory postulate the existence of a visual memory function, and theories of the reading process hypothesise that the orthographic identity of a word becomes incorporated with other facets of the word's identity to form a total unit.

Empirical research studies have investigated the language abilities of the deaf. These studies have hypothesised that the word perception capabilities of the deaf appear to be dependent upon the utilisation of visual characteristics of a language. Other research studies have attempted to investigate assumptions derived from theory which relate the influence of visual factors to the spelling process. However, the results are varied and in some cases contradictory. For these empirical studies visual memory has had to be operationally defined, as for example, by scores on visual discrimination tasks, visual recognition tasks, written tasks and letter counting tasks, and correlated with some measure of spelling performance. The variability of the results and the conclusions drawn reveal the uncertainty about the existence and function of visual memory in the spelling process.

Study in Context

The complexity of investigating visual memory and its relationship to the spelling process would seem to be abundantly clear from the literature review. Perhaps a major stumbling block to this line of inquiry has been the apparent need to isolate and test parts of a process, when in fact the process may be an interdependent whole. The present study does not claim to have overcome this problem. However, it does attempt to look at what children do when they are spelling.

The study takes up a line of inquiry given a cursory mention by Marsh et al. (1980) in their work entitled 'The Development of Strategies in Spelling'. How do children learn to spell words containing silent letters? The work of Marsh et al. (1980) includes a discussion of the relationship of decoding strategies in reading and spelling. They point out the differences in the predictability of spelling-to-sound and sound-to-spelling correspondences by using the pronunciation of the letter K, and the spelling of the phoneme /K/. The orthographic-to-oral process of pronouncing K produces /K/, except where the situation is Kn..., and the K is then silent. However, spelling the phoneme /K/ is quite different. For example, /K/ can be represented by c as in cut, k as in kite, ck as in neck, and ch as in school. Marsh et al. (1980) contend that "there is no simple way to predict whether or not a word begins with a silent letter k. The correct spelling of words with an initial silent k before n must depend primarily on visual memory" (p.343).

The purpose of the present study was to investigate children's spelling of words containing silent letters, in this case consonants. Such questions as the following directed the line of research taken: are silent letters distinguishing visual features of words? are the silent letters included in incorrect attempts at spelling words containing silent letters? is there a developmental pattern evident in the representation of silent letter words by primary school children?

Word frequency effect was a variable chosen for analysis in this study. It was hypothesised that the greater the chance of exposure to a written word, the greater would be the chance that a visual representation of the word might be stored. The Carroll et al. (1971) written word frequency count was used to select words of relatively high and low occurrence in printed material, the hypothesis being that there would be a relationship between written word frequency and spelling performance. That is, the higher the frequency, the more accurate the spelling of a word.

Position of the silent letter in the word was another variable chosen for analysis. Jensen (1962) and Kooi et al. (1965) have demonstrated that the serial-position effect occurs when the distribution of spelling errors is plotted according to their position in the word. That is, spelling errors occur more frequently in the middle of words, with fewest errors occurring at the beginning and end of words. Therefore, words with silent letters occurring in varying positions in the word were chosen for investigation.

Research Design

The main purpose of this study was to investigate the spelling performance of a sample of Year 2, 3 and 4 children when attempting to spell a selection of words containing silent consonants.

This section of the report describes the following aspects of the research design: sample selection; testing material; procedure (test instructions, administration and method of data collection); statistical treatment of data; and limitations to the study.

Sample Selection

It was decided to select a sample of pupils from Years 2, 3 and 4 in the Victorian State Primary School system as the testing population. The choice of these classes was based on the assumption that a range of age-based classes might reflect differential levels of spelling experience. Thus, it was assumed that Years 2, 3 and 4 would encompass part of the continuum of dependent beginner spellers to proficient independent spellers.

TABLE 2

Sample Selection

		Year 2	3	4	
30 Schools	Female	60	60	60	180
	Male	60	60	60	180
		120	120	120	360

A random sample of 30 State Primary Schools was drawn from the school population of Metropolitan Melbourne. Metropolitan Melbourne was defined as in the Teachers' Tribunal, Teaching Service Regulations, Regulation 4, Part 3(c) (Education Gazette and Teachers' Aid, 12th December, 1979).

From the 30 Primary Schools selected, the sample for this study was drawn in the following manner: the population from which the sample was chosen was defined on a dual criteria basis, viz homogeneity of class, and age span within each class. Four children, two female and two male were chosen from each of Years 2, 3 and 4 thus giving a total sample number of 360 subjects. (Table 2)

The criterion for selection of subjects within each Year was determined by specifying a particular date of birth. In Year 2, in each school, two females and two males whose birth date was closest to the 15th February, 1972 were chosen as the sample. In Year 3 the birth date criterion was the 15th February, 1971. In Year 4 the birth date criterion was the 15th February 1970. These dates were chosen on the basis that they were approximately the middle of the age range at each year level.

The sampling procedure involved two further considerations:
(i) children with gross sight, hearing or speech difficulties were excluded from the sample;
(ii) also excluded from the sample were newly arrived migrant children: these were defined as children who had not had at least two and a half years at school in an English speaking country.

TABLE 3

YEAR 2 Age Data

YEAR 2	Age Range	Mean	Mode
Total Number of Children = 120	7yrs 6mths - 8yrs	7yrs 8.9mths	7yrs 9mths
Females = 60	7yrs 8mths - 7yrs 10mths	7yrs 8.9mths	7yrs 9mths
Males = 60	7yrs 6mths - 8yrs	7yrs 8.95mths	7yrs 9mths

TABLE 4

YEAR 3 Age Data

YEAR 3	Age Range	Mean	Mode
Total Number of Children = 120	8yrs 7mths - 8yrs 11mths	8yrs 8.9mths	8yrs 9mths
Females = 60	8yrs 8mths - 8yrs 11mths	8yrs 9.06mths	8yrs 9mths
Males = 60	8yrs 7mths - 8yrs 11mths	8yrs 8.8mths	8yrs 9mths

TABLE 5

YEAR 4 Age Data

YEAR 4	Age Range	Mean	Mode
Total Number of Children = 120	9yrs 7mths - 9yrs 11mths	9yrs 8.8mths	9yrs 9mths
Females = 60	9yrs 7mths - 9yrs 11mths	9yrs 9mths	9yrs 9mths
Males = 60	9yrs 7mths - 9yrs 10mths	9yrs 8.8mths	9yrs 9mths

During the initial visit to the school, information was collected on the language background of the children in the sample. Teachers were asked whether the children in the sample spoke a language other than English, and if so, which language was spoken, but there was no information gathered on the child's facility with the second language, or whether it was the language used at home. For the purpose of this study, the children were divided into two groups: those who speak a second language (Bilingual), and those whose only language is English (Monolingual). The numbers of Bilingual and Monolingual children at each year level are shown in Table 6. Bilingual children made up 22.5% of the sample.

A Measure of General Spelling Performance

For analytic purposes it was also decided to divide the 360 subjects into three spelling ability groupings. Eighteen words were specifically chosen as a measure of general spelling performance and included in the corpus of words constituting the testing material. The words were selected from the first 10,000 words of The American Heritage Word Frequency Book, (Carroll et al., 1971).

TABLE 6

Numbers of Bilingual and Monolingual Children at Each Year Level

	Bilingual children	Monolingual children	
YEAR 2	29	91	120
YEAR 3	24	96	120
YEAR 4	28	92	120
Total	81	297	360

Six words were chosen from the first 1,000 words, six from the 1,000-2,000 range, and six from 2,000-10,000. As well as frequency, length of the words was also considered. Two short words (less than five letters), two medium length words (five to seven letters), and two long words (more than seven letters) were chosen randomly from each frequency range. Homophones and words with alternative spellings were omitted. Table 7 shows the words selected, and the selection criteria.

TABLE 7

Words used to Measure General Spelling Performance, showing Selection Criteria

	Short Words	Medium Words	Long Words
Frequency range 0-1,000	moon wide	people anyone	answered afternoon
Frequency range 1,000-2,000	cost bowl	supper imagine	suggested watching
Frequency range 2,000-10,000	dull knob	husky revenge	horrible destroyed

The group designated as the low spelling ability group consisted of 119 subjects, whose scores ranged from 0-4 words correct; the medium spelling ability group, those who scored 5-10 correct, consisted of 122 subjects; and there were 119 in the high spelling ability group, those who scored 11 or more correct. The numbers of children at each year level in each spelling ability group are shown in Table 8.

TABLE 8

Numbers of Children at each Year Level in each Spelling Ability Group

	Low Spelling Ability	Medium Spelling Ability	High Spelling Ability	
YEAR 2	79	33	8	120
YEAR 3	28	54	38	120
YEAR 4	12	35	73	120
TOTAL	119	122	119	360

Testing Material

The purpose of this study was to investigate the spelling performance of children when attempting to orthographically represent words containing silent consonants.

Several criteria were taken into account when selecting the silent consonant words to be tested:
i) Homonyms were excluded;
ii) Samples of words with silent consonants at the beginning, middle and end were chosen, eg. knife, castle, lamb;
iii) Words in each of the above mentioned categories were then selected on the basis of frequency of occurrence in written material. The basis of this criterion was the work of Carroll et al.(1971) who analysed a selection of over five million words (tokens) taken from a selection of textbooks, workbooks, kits, novels, poetry, general non-fiction, encyclopaedias and magazines representing as nearly as possible the range of required and recommended reading in the school grades three to nine in the United States (Carroll et al., 1971, p.xiii). Among the many statistics computed on this data a rank listing of the word types was calculated. It was on the basis of this rank listing that the frequency criterion was judged and 20 words containing silent consonants were chosen for the spelling task. Those words containing the relevant silent consonants that had a frequency range of less than 5,400-5,500 were designated as High Frequency words. Those silent consonant words with a frequency ranking above 5,500 were designated as Low Frequency words. (Table 9) There was no assessment made as to whether the silent consonant words designated as of relatively high, or as of relatively low frequency of written occurrence, were within the 360 individual children's recognition capacity.

TABLE 9

Silent Letter Test Words and their Frequency of Occurrence

Words Designated as High Frequency		Words Designated as Low Frequency	
TEST WORD	FREQUENCY RANGE	TEST WORD	FREQUENCY RANGE
Beginning Silent Consonant - K			
knife	1,400 - 1,500	knitting	9,200 - 9,300
knee	3,900 - 4,000	knack	18,000 - 18,100
knock	4,200 - 4,300	knuckle	23,400 - 23,500
Beginning Silent Consonant - W			
wreck	4,700 - 4,800	wrench	13,000 - 13,100
wrist	5,000 - 5,100	wriggle	24,900 - 25,000
Middle Silent Consonant - t			
castle	2,400 - 2,500	thistle	22,500 - 22,600
whistle	2,700 - 2,800	gristle	84,700 - 84,800
End Silent Consonant - b			
climb	1,600 - 1,700	dumb	7,300 - 7,400
thumb	2,800 - 2,900	tomb	8,900 - 9,000
lamb	4,300 - 4,400	crumb	25,100 - 25,200

(Rank order as presented in The American Heritage Word Frequency Book, Carroll, et al., 1971.)

This particular study was one part of a larger study into aspects of children's spelling, which consisted of three parts (Elliott, 1982, Thomas, 1982). When the test words from each of the three parts were randomly combined, a corpus of 128 words was formed. These words were then divided into three sub-tests, two tests of 43 words each, and one of 42 words. Accompanying sentences for each word were formulated, and an effort was made to construct meaningful contexts for each word (Appendix I).

Two versions of the test were constructed, Version A (Test I, II and III) and Version B (Test I, II and III). To encourage a positive attitude in the test situation each test began with four words considered to be the most simple on each test.

Following these first four words, the remaining words in the Version B lists were in reversed order to Version A lists. Version A and B were each administered to 15 schools.

Procedure: Instructions, Administration and Data Collection.

An initial visit was made to each school, subjects were selected and a quiet working area arranged for the testing sessions. Each of the three sub-tests of either Version A (IA, IIA, IIIA) or Version B (IB, IIB, IIIB) were administered consecutively and where possible on consecutive school days. This could not always be arranged due to the daily routine of schools, eg. excursions, films and sports days.

The Year 2 children were tested as a group by themselves. However, the Year 3 and 4 children were tested together as one group, or in separate sessions, depending on the availability of the children, and of space for testing. Actual testing time varied considerably from year level to year level, and from school to school.

Five testers were involved in the data collection stage of this study. Briefing sessions with the testers were conducted to maximise uniformity of instruction, administration and pronunciation of each of the test words. Once rapport was established with the children each tester gave the following instructions:

Tester

I'm interested in how children learn to spell, so I'm asking a lot of children to do some spelling for me.
You're not expected to get all the words right, but I'd like you to try and spell all the words.
If you make a mistake, don't rub it out, just print the word again.
If you can't keep up, tell me, and I'll go a bit slower.
I'll read a sentence which has the word in it first, then I'll tell you the word I want you to spell.
I'll tell you twice, so, if you don't hear it the first time, you'll have another chance to hear it.
If you still aren't sure what the word is, ask me, and I'll say it again.
Some of the words you may not know the meaning of - listen carefully, and try to spell the word anyway.

Data collection commenced in the last week of October 1979, and continued for six weeks.

Statistical Treatment of the Data

The data were analysed using the S.P.S.S.* program Frequencies, Spearman Rank Order Correlation statistics and the S.P.S.S. program Crosstabs in conjunction with a specially devised coding schedule for the classification of spelling errors. (See Appendix VI)

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* Nie, N.H., Hull, C.H., Jenkins, J.G., Steinbrenner, K. & Bent, D.H. Statistical Package for the Social Sciences. 2nd Edition. New York: McGraw-Hill, 1975.

Limitations to the Study

In this study of an aspect of language development the relatively isolated method of presentation of each test word is a limitation. The test words used in this study were presented orally in a sentence and then in isolation. The oral method of presentation may have influenced the strategies the children utilised.

The use of a methodological approach of observing children's spelling within their writing would need to be considered in any future research. No attempt was made to check whether the silent consonant test words used in this study were within the individual children's word recognition lexicon. In a future study this limitation would also need to be taken into account.

Results

Year Level and Spelling Performance

The words containing silent consonants which had been spelled correctly were analysed by year level.

It was found, as was to be expected, that the number of children who correctly spelled each of the 20 silent consonant words was greater in Year 4 than in Year 3, and greater in Year 3 than in Year 2.

TABLE 10

Year Level and Spelling Performance

Silent Consonant Words (Order Based on Frequency Measure)	Number Correct Year 2 (N=120)	Year 3 (N=120)	Year 4 (N=120)
knife	23	73	95
climb	26	67	94
castle	11	53	78
whistle	6	39	66
thumb	28	69	89
knee	37	78	99
knock	21	49	84
lamb	41	80	99
wreck	4	20	35
wrist	6	29	53
dumb	5	32	61
tomb	0	11	22
knitting	4	32	50
wrench	3	14	30
knack	3	14	37
thistle	7	33	54
knuckle	2	13	37
wriggle	4	28	45
crumb	20	55	69
gristle	3	17	29

(See Appendix II)

Ability Grouping and Spelling Performance

The words containing silent consonants which had been spelled correctly were analysed by ability grouping. The results indicate that, as was to be expected, the number of children who correctly spelled each of the 20 silent consonant words was greater for ability grouping 3 (High Spelling Ability) than ability grouping 2 (Medium Spelling Ability), and greater for ability grouping 2 than for ability grouping 1 (Low Spelling Ability).

TABLE 11

Ability Grouping and Spelling Performance

Silent Consonant Words (Order Based on Frequency Measure)	Percentage Correct		
	Low Spelling Ability (Group 1 N=119)	Medium Spelling Ability (Group 2 N=122)	High Spelling Ability (Group 3 N=119)
knife	10.1	56.6	92.4
climb	5.9	57.4	92.4
castle	3.4	28.7	86.6
whistle	0	18.0	74.8
thumb	8.4	54.9	91.6
knee	13.4	66.4	98.3
knock	4.2	38.5	85.7
lamb	16.0	68.9	98.3
wreck	0	3.3	46.2
wrist	0	11.5	62.2
dumb	2.5	18.9	60.5
tomb	1.7	3.3	22.7
knitting	1.7	17.2	52.9
wrench	0	4.1	35.3
knack	0.8	7.4	37.0
thistle	0.8	16.4	61.3
knuckle	0	4.1	39.5
wriggle	0	12.3	52.1
crumb	4.2	32.8	83.2
gristle	0	10.7	30.3

(See Appendix III)

Language Background and Spelling Performance

The pattern of spelling success for bilingual and monolingual children was very similar. The monolingual children, as a group, were more successful at spelling the silent consonant words than the bilingual group, but the difference was not great. The mean percentage correct for the bilingual group was 23.89%. The mean percentage correct for the monolingual group was 34.03%. The mean percentage difference between the two groups on the silent letter words was 10.14%. The range of differences was from 3.5% for the word knack (bilingual group 12.3% correct - monolingual group 15.8% correct), to 19.3% for the spelling of climb (bilingual group 37% correct - monolingual group 56.3% correct). (See Appendix IV for details)

Word Frequency and Spelling Performance

Word frequency effect was a variable chosen for analysis in this study. It has been argued that the greater the chance of exposure to a written word, the greater would be the chance that a visual representation of the word might be stored.

A written word frequency count (Carroll et al., 1971) was selected to be used as a measure of word frequency, the hypothesis being that there would be a positive relationship between written word frequency and spelling performance. The 20 silent consonant test words that comprised the data for this study were assigned numbers representing frequency of occurrence in written language on the basis of Carroll et al. (1971). (Table 9)

The words were then arranged in rank order from highest to lowest frequency. For each year level, the 20 words were then arranged in rank order on the basis of number correct. (See Appendix V) A Spearman Rank Order Correlation Coefficient was calculated for each year level. (Table 12)

A statistically significant correlation was obtained for each of the Year levels 2, 3 and 4. The results indicate a positive correlation between the frequency ranking and the children's spelling success of the silent consonant words involved in this study.

TABLE 12

Correlation Coefficient between Frequency Ranking and Success Ranking for each Year Level

Year	Spearman Rank Order Correlation Coefficient (r_{rho})	Level of Significance
2	.63	$P < .01$
3	.63	$P < .01$
4	.68	$P < .01$

(See Appendix V)

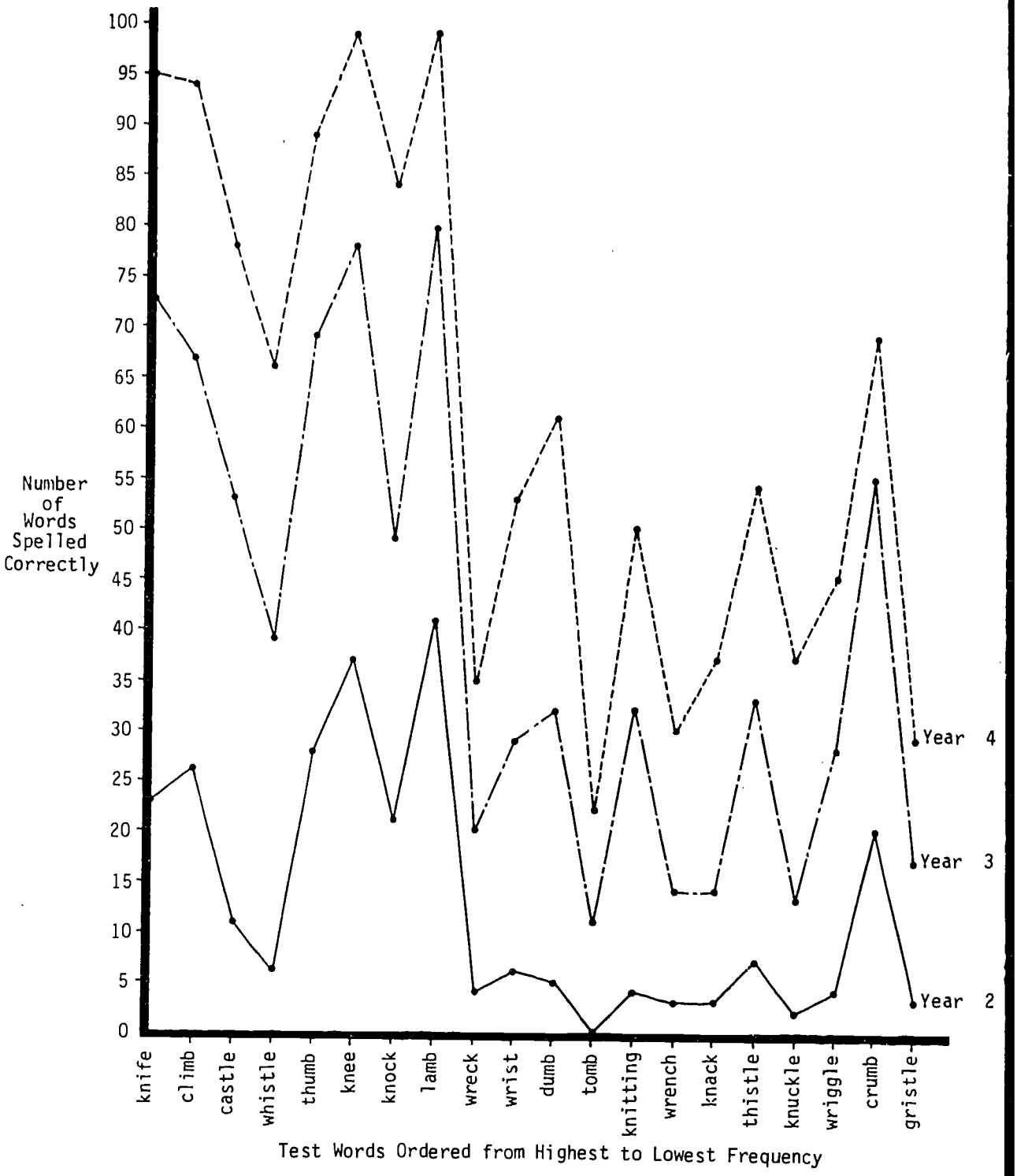

Figure 5: Number Spelled Correctly as a Function of the Word's Frequency of Occurrence

A positive correlation between frequency and success rate having been established, the data were then analysed comparing the high frequency group of words with the low frequency group of words for beginning, middle and end silent consonants.

The 20 silent consonant words were divided into those designated high frequency and those designated low frequency as in Table 9. Each high frequency word was then compared to all the low frequency words in the same category. For instance, knife, knee and knock were designated as the high frequency group of words beginning with a silent k. The words knitting, knack and knuckle were designated as the low frequency group of words beginning with a silent k. One question asked was, for example: "Is knife more correctly spelled by each year level than all the low frequency words in the silent k group?" The following tabulation (Table 13) was made for each category of words.

With only a few exceptions the high frequency silent consonant words were spelled correctly more often than the low frequency words.

TABLE 13

Comparison of High and Low Frequency Words by Year Level

Words Designated as High Frequency	Year level 2	3	4	Words Designated as Low Frequency
	+ indicates that the high frequency word was spelled correctly as often, or more often, than every word in the low frequency category			
knife	+	+	+	knitting, knack
knee	+	+	+	knuckle
knock	+	+	+	
wreck	+	-	-	wrench, wriggle
wrist	+	+	+	
castle	+	+	+	thistle, gristle
whistle	-	+	+	
climb	+	+	+	dumb, tomb, crumb
thumb	+	+	+	
lamb	+	+	+	

Analysis of Errors

The silent consonant words chosen for analysis in this particular study were selected on the assumption that a visual memory capacity would facilitate the spelling of such words. With no obviously apparent reason for knee to be spelled with a k, or thumb to be spelled with a b, the assumption is that there is a particular visualisation function utilised for a child to produce the correct spelling. One interesting question that arises is whether children who spell the silent consonant words incorrectly retain the silent letter in their spelling attempt. Therefore, the data were analysed so that every incorrect attempt was checked for the inclusion of the relevant silent consonant.

A coding schedule was devised to classify the spelling attempts according to whether they were (1) correct, (2) incorrect, but with the relevant silent letter included in the attempt, (3) incorrect, but with no silent letter included in the attempt, or (4) an unclassifiable attempt. (Appendix VI) The results which were obtained from this analysis are shown in Tables 14 - 16.

TABLE 14

Children's Spelling Classified by Whether or Not the Relevant Silent Consonant was Included - Year 2

Spelling Word with relevant Silent Consonant underlined	Correct Attempt	Incorrect Attempt		
		Silent letter included	Unclassifiable	Silent letter not included
	%	%	%	%
knife	19.2	25.8	5.0	50.0
knee	30.8	12.5	6.7	50.0
knock	17.5	8.3	5.0	69.2
knitting	3.3	16.7	8.3	71.7
knack	2.5	2.5	5.0	90.0
knuckle	1.7	5.0	7.5	85.8
wreck	3.3	0	6.7	90.0
wrist	5.0	0.8	6.7	87.5
wrench	2.5	0	8.3	89.2
wriggle	3.3	8.3	6.7	81.7
castle	9.2	13.3	5.8	71.7
whistle	5.0	6.7	5.8	82.5
thistle	5.8	0.8	10.0	83.3
gristle	2.5	4.2	9.2	84.2
climb	21.7	1.7	9.2	67.5
thumb	23.3	2.5	7.5	66.7
lamb	34.2	0.8	6.7	58.3
dumb	4.2	0	9.2	86.7
tomb	0	0.8	7.5	91.7
crumb	16.7	0	5.8	77.5

TABLE 15

Children's Spelling Classified by Whether or Not the Relevant Silent Consonant was Included - Year 3

Spelling Word with relevant Silent Consonant underlined	Correct Attempt	Incorrect Attempt		
		Silent letter included	Unclassifiable	Silent letter not included
	%	%	%	%
knife	60.8	20.0	0.8	18.3
knee	65.0	7.5	0	27.5
knock	40.8	20.0	0.8	38.3
knitting	26.7	25.8	0.8	46.7
knack	11.7	3.3	0.8	84.2
knuckle	10.8	13.3	0.8	75.0
wreck	16.7	5.8	3.3	74.2
wrist	24.2	0	0.8	75.0
wrench	11.7	1.7	2.5	84.2
wriggle	23.3	15.0	0.8	60.8
castle	44.2	13.3	1.7	40.8
whistle	32.5	17.5	1.7	48.3
thistle	27.5	5.8	1.7	65.0
gristle	14.2	5.8	1.7	78.3
climb	55.8	5.8	2.5	35.8
thumb	57.5	1.7	2.5	38.3
lamb	66.7	0.8	0	32.5
dumb	26.7	0.8	2.5	70.0
tomb	9.2	1.7	4.2	85.0
crumb	45.8	1.7	5.0	47.5

TABLE 16

Children's Spelling Classified by Whether or Not the Relevant Silent Consonant was Included - Year 4

Spelling Word with relevant Silent Consonant underlined	Correct Attempt	Incorrect Attempt		
		Silent letter included	Unclassifiable	Silent letter not included
	%	%	%	%
knife	79.2	8.3	0.8	11.7
knee	82.5	5.8	3.3	8.3
knock	70.0	11.7	1.7	16.7
knitting	41.7	22.5	0.8	35.0
knack	30.8	6.7	1.7	60.8
knuckle	30.8	16.7	1.7	50.8
wreck	29.2	5.8	4.2	60.8
wrist	44.2	4.2	3.3	48.3
wrench	25.0	3.3	2.5	69.2
wriggle	37.5	13.3	0.8	48.3
castle	65.0	10.8	1.7	22.5
whistle	55.0	15.8	0.8	28.3
thistle	45.0	5.8	3.3	45.8
gristle	24.2	10.8	2.5	62.5
climb	78.3	2.5	1.7	17.5
thumb	74.2	4.2	0.8	20.8
lamb	82.5	0	0.8	16.7
dumb	50.8	0	2.5	46.7
tomb	18.3	2.5	0.8	78.3
crumb	57.5	0	6.7	35.8

The code 2 (silent consonant included in incorrect attempt) data contained in Tables 14, 15 and 16 gives some credibility to the notion of a visualisation function in the spelling process. This assumption is based on the numbers of children in Year 2, 3 and 4 who included the relevant silent consonant in their incorrect attempt at the word. The children who produced attempts like the following:

knee - kney, whistle - wistle, climb - ckimb, wreck - wreak, would appear to be utilising some knowledge of acceptable visual orthographic patterns in the English language.

To further investigate the notion of the visualisation function being utilised in the spelling process the data were re-analysed by ability groupings. The results of this analysis are contained in Table 17.

TABLE 17

Silent Consonants Included in Incorrect Attempts Expressed as a Percentage of the Classifiable Incorrect Attempts Tabulated by Spelling Ability Grouping

Spelling Word with relevant Silent Consonant underlined	Spelling Ability Grouping		
	Low Spelling Ability Group (1) %	Medium Spelling Ability Group (2) %	High Spelling Ability Group (3) %
knife	26.3	60.4	77.8
knee	16.3	37.5	50.0
knock	10.3	38.4	52.9
knitting	7.3	35.4	64.8
knack	1.8	2.7	13.5
knuckle	2.8	12.8	33.3
wreck	0.9	4.3	14.0
wrist	0	3.8	4.5
wrench	1.9	0	5.2
wriggle	6.4	10.3	45.6
castle	10.5	31.4	43.8
whistle	3.6	27.3	56.7
thistle	1.0	9.1	10.9
gristle	3.8	4.7	19.3
climb	2.1	13.5	33.3
thumb	2.0	7.4	44.4
lamb	1.1	2.6	0
dumb	1.0	0	0
tomb	0	2.6	3.3
crumb	1.0	1.3	0

The figures in Table 17 (i.e. the percentages of children in each ability group who included the relevant silent consonant in their classifiable incorrect attempts), show that it is the higher ability groups who include the silent consonants more frequently.

The low ability group (1) has the highest number of errors but the lowest number of inclusions of silent consonants. The groups of higher spelling ability (i.e. groups 2 and 3) appear to be utilising this visualisation capacity to a greater extent.

Position of Silent Consonant and Spelling Performance

As reported in the Review of Research Literature - Study in Context section, previous research has demonstrated that spelling errors occur more frequently in the middle of words, with fewest errors occurring at the beginning and end of words. To investigate this position effect with the spelling of silent consonant words proved to be very difficult.

In order to attempt to investigate this position effect with the spelling of silent consonant words, certain variables need to be controlled before comparisons can be made. The results of this report have already shown a positive correlation between word frequency and children's spelling success. (Table 12 and Figure 5) It is clear from the results in Table 13 that words designated as high frequency are spelled correctly more often than words designated as of low frequency. To compare the children's performance on the three groups of words (beginning, medial and final silent consonants) words of the same frequency are needed. Words with silent consonants at the beginning, middle and end of words were available, as were words classified as of high and low frequency of occurrence. However, to match position of silent consonant and frequency proved to be an almost insurmountable problem. (Table 9: Silent Letter Test Words and their Frequency of Occurrence, shows the diversity of frequency ranges not only between, but within the frequency classification).

To investigate whether the children included the silent consonant in their incorrect attempt at a word more frequently if the letter was in one position rather than another, a further restriction was necessary. For comparisons to be made, not only frequency of word, and position of relevant silent consonant needed to be controlled, but also number of correct spellings of each word. If the number of correct spellings is the same, this means that the number of incorrect spellings in which a child might include a relevant silent consonant is also the same. Therefore, valid comparisons can be made. The results of only two pairs of silent consonant words came close to fulfilling these three criteria. The percentages of children who included the relevant silent consonants in their incorrect attempts at these four words are shown in Table 18.

TABLE 18

Comparison of Percent Correct, and Percent Incorrect but Including Relevant Silent Consonant in Pairs of Words Similar in Length and Frequency, Tabulated by Spelling Ability Groups

Spelling Word with relevant Silent Consonant underlined		% Correct			% Including relevant Silent Consonant in Incorrect Attempts		
		Spelling Ability Group			Spelling Ability Group		
		Low (1)	Medium (2)	High (3)	Low (1)	Medium (2)	High (3)
	Frequency						
knife	(1,400-1,500)	10.1	56.6	92.4	21.8	26.2	5.9
climb	(1,600-1,700)	5.9	57.4	92.4	1.7	5.7	2.5
wriggle	(24,900-25,000)	0	12.3	52.1	5.9	9.0	21.8
thistle	(22,500-22,600)	0.8	16.4	61.3	0.8	7.4	4.2

For the beginning silent k in knife, and the final silent b in lamb, it is clear that for all three spelling ability groups the beginning silent k was included more frequently in the children's incorrect attempts than was the final b in lamb. (Table 18)

For the beginning silent w in wriggle, and the medial silent t in thistle, the results show that the beginning silent w was included more frequently by each ability group in their incorrect attempts at wriggle than was the medial t in thistle. (Table 18) (Results tabulated by year level are contained in Appendix VII)

It would seem from these very limited results that there is a tendency for the beginning silent consonants to be more readily reproduced than medial or final consonants, a finding consistent with the idea of a visual factor operating in the spelling process.

Discussion

The results obtained in this study show that the children's ability to spell the 20 silent consonant words was greater in Year 4 than in Year 3, and greater in Year 3 than in Year 2. (Table 10)

These results are to be expected if one assumes that greater familiarity with written language will lead to greater competence in the use of that language. Familiarity with written language conventions incorporates not only knowledge of the visual structure of words and acceptable orthographic patterns, but also of complex phoneme-grapheme relationships as Elliott (1982) has shown, and of morphemic relationships as shown by Thomas (1982).

The results also show a positive and significant correlation between word frequency ranking and spelling success for each of the three year levels involved in this study. (Tables 12, 13 & Figure 5). The results indicate that the more frequently a word appears in written material the greater the possibility of the children spelling it successfully. One may conjecture that if a child uses visual memory of a word when attempting to write it, then the greater the chance of exposure to a word, the greater must be the possibility of recalling the word's spelling for production purposes.

If after producing an attempt at the spelling of a word a child considers whether it looks right, then once again the greater the chance of exposure to a word the greater the chance that a child can recognise the correctness of the spelling. This is not to state categorically that mere exposure to a word will be enough to ensure the ability to recall or recognise the particular word concerned on another occasion. The quality of the visual exposure to the word must be considered an important variable in the retention process. A child who looks at a word with some interest, or for some purpose, may experience a qualitatively different exposure to a word than a child who is uninterested. The former child may be able to recognise, or recall the word after only one observation, but the latter child may need many exposures.

Of the 20 silent consonant words included in this study, two individual cases appear as anomalies to the frequency - success hypothesis. The word tomb was most often spelled incorrectly of all the 20 words for all three of the year levels involved. (See Appendix II) But tomb was more frequent than eight of the other silent consonant words. (Table 10) On a 1-20 ranking scale, tomb was ranked 12th on a frequency basis and

20th when ranked on the number spelled correctly. The word crumb was classified as a very low frequency word. However, the children were able to spell crumb with more success than many of the other higher frequency words. Of the 20 silent consonant test words, crumb was ranked 19th on the frequency basis. However, when ranked on the number spelled correctly, crumb was 7th for Year 2, 6th for Year 3 and 8th for Year 4. (Appendix II)

An important consideration to bear in mind at this point is the source of the material used to make the frequency classification. The American Heritage Word Frequency Book, Carroll et al. (1971) was selected for basically two reasons: i) The dearth of Australian publications involving frequency counts of either written or oral language. ii) The apparently extensive nature of the Carroll et al. (1971) study, for which over five million words (tokens) were analysed encompassing the reading material of grades three to nine in the U.S.A.

When the results of tomb and crumb are considered, there is a possibility that the Carroll et al. (1971) frequency analysis may not totally reflect the Victorian situation. The word crumb appears in Level 7 of the N.Z.C.E.R. Alphabetical Spelling List Book 2 (1st Edition, 1961) whereas tomb does not appear at all. The N.Z.C.E.R. spelling publication is available in Victoria. Both tomb and crumb appear in the Reference List of the Education Department of Victoria's publication, Spelling Grade III to Form II (1970), but not in the 16 Spelling Levels. The possibility arises that for Victorian children crumb may be a more familiar word than the Carroll et al. (1971) study would indicate.

The other issue this result highlights is the nature of the concept of word frequency. A gross measure of word frequency such as a frequency count was used in this study. But it must be pointed out that because a word has a high frequency classification it does not mean a child has been exposed to that word. What has been frequently seen and written by one individual child is not necessarily the same for another child. However, it would have been impractical to test all the children to determine if a given set of words was within their recognition capacity.

It has been argued in the results section that some credibility to the notion of a visualisation function in the spelling process can be assumed by the data of children who included the relevant silent consonant in their incorrect attempts at a word. (Tables 14-17). The use of a phoneme-grapheme matching strategy might produce spelling attempts like knife - nif, niff, knee - nee, ne, nie, lamb - lam, wreck - rek, rec, and thistle - thisl, thisel. However, spelling attempts like knife - knif, knee - kney, lamb - land, lamp, wreck - wrech, wreack, and thistle - thithel, would seem to involve an additional strategy utilising a cognitive capacity to visualise a word's characteristics.

If we assume that the inclusion of the silent letter is a reflection of the visual memory process in spelling, then we must consider two other issues. First, in the children's incorrect spelling attempts are there other letters used in place of the correct silent letter? For example, is the beginning of the kn words spelled any other way than k... or n... ? An analysis of the data resulted in the following information: for the six kn words (knife, knee, knock, knitting, knack, knuckle), for the Year levels 2, 3 and 4 there were 21 incorrect spellings which did not start with either a k or an n. Of these attempts, 19 were of an unclassifiable nature, as for example, knife spelled by a Year 2 child as mfood, knock spelled by a Year 3 child as vogge, and knuckle spelled by a Year 4 child as cono. However, the remaining two attempts were interesting.

A Year 3 child spelled knack as gnack, and a Year 4 child spelled knack as gnac. What prompted these children to spell knack as gn...? It could not have been a visual image of the word knack. However, if they were using knowledge of orthographic structures, they could have associated knack with gnome, gnash, gnat or gnaw. The children may have used both a phoneme-grapheme and a visual strategy when attempting to spell these words.

It must be remembered at this point, that in this study the spelling task was presented orally to the children, thus emphasising the sound aspects of language. This may have lead the children to over rely on a phoneme-grapheme matching strategy.

Of the wr words (wreck, wrist, wrench, wriggle) for the three year levels, there were six incorrect spellings which did not start with either a w or an r. All six attempts were of an unclassifiable nature. For example, wriggle was spelled by a Year 2 child as tglb, and wrist was spelled by a Year 2 child as ansted.

However, interesting data can be found by analysing the incorrect attempts of the word lamb, which was spelled as lame by 16 Year 2, 12 Year 3 and six Year 4 children, and as lamp by eight Year 2, seven Year 3 children and one Year 4 child. Lamb was also spelled as lamd by four Year 2 children and one Year 3 child.

The spelling of lamb as land, lamp or lamd seems to suggest the use of a knowledge of the visual structure of the word. This visual knowledge may incorporate knowledge about what are acceptable graphemic combinations in English.

The second issue to consider is whether the children used common silent consonant graphemic combinations in the spelling of other words in the study, thus making the spelling of those words incorrect. For example, did the children in this study spell risks (Word 28, List IIIA) as wrisks, or was needed (Word 28, List IA) spelled kneeded? Of the words available for analysis there were some interesting results. There were six attempts to spell risks beginning with a w. For instance, two children spelled risks as wisx, and two spelled risks as wrisks. Four children spelled needed beginning with kn: two examples of kneaded, and one each of kneeded and kneedeing.

Two other very interesting results were extrapolated by this method of analysis: first the spelling of revenge by a Year 4 child as wreveng; secondly, the spelling of the word noticing as knowticing and knotising by two Year 3 children, and as knowtsing and knorcing by two Year 4 children. These children could not have been using visual memory in the form of a visual image of the word. One explanation of such results could be that the children were spelling by utilising known orthographic letter patterns. These attempts require a combination of strategies, as neither a phoneme-grapheme strategy nor the utilisation of visual memory alone could be responsible for the spellings produced.

Spelling strategies such as the ones already discussed are not necessarily restricted to young spellers. For example, a combination of strategies would seem to be indicated by the following examples of spellings taken from the writings of H.S.C. students:

. wrather	(rather)
. wreckon	(reckon)
. sugar plumb	(plum)

These spellings seem to reflect a knowledge of known legitimate orthographic letter patterns.

. a garden knome	(gnome)
. his knarled, filthy little hand	(gnarled)

These spellings seem to reflect not only a knowledge of acceptable graphemic combinations but some knowledge of the visual structure of the word to be spelled.

Conclusion

The data in the Analysis of Errors section of this report gives some credibility to the notion of a visualisation function in the spelling process, but not as a photographic or mental visual image as suggested by some authors. Radaker (1963), Hendrickson (1967), Woodland (1975) and Caban et al. (1978) have all written about the concept of visual memory in terms of seeing an object or event again, or thinking in terms of mental pictures. However, the research reported here does not necessarily support the view that visual memory is synonymous with a photographic image of a word. It would seem that visual memory involves the cognitive retention of visual information about a word's structure. This information contains the orthographic identity or the correct graphemic combination necessary for the spelling of the word. However, it is not solely by creating a visual image of the word's form as Radaker (1963) and Walker (1974) have suggested. If this were the case it would be difficult to explain such attempts as knowticing for the word noticing, wrisks for risks or kneaded for needed.

The data in this study supports the notion of the development of a visual cognitive strategy for dealing with English orthography. This visual strategy incorporates the use of a knowledge of acceptable visual orthographic patterns in the English language. The utilisation of this visual strategy may not occur in isolation but as part of a combination of strategies acquired through experience with language in both the written and oral form. Thus the integrally related aspects of the language process need to be considered carefully in any spelling research. Although this study provides evidence for the role of a visual cognitive strategy being involved in the spelling process it has not solved the methodology difficulties of isolating such a phenomenon.

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APPENDIX I

Spelling Test Version A

LIST IA

1.	We used the paper to draw on.	paper
2.	We are all at school today.	school
3.	There were black and white kittens in the basket.	black
4.	The rabbit's fur was soft.	soft
5.	She turned the knob to open the door.	knob
6.	We ate everything on the plate.	everything
7.	I will leave early today.	leave
8.	He was a big husky footballer.	husky
9.	Mum said she didn't have any money.	any
10.	We had hot chocolate for supper.	supper
11.	It is my birthday next month.	birthday
12.	He only had one leg.	one
13.	Christmas is coming soon.	coming
14.	He is sometimes late for school.	sometimes
15.	The car radiator was boiling.	radiator
16.	We had a picnic lunch in the garden.	picnic
17.	The cat drank all his milk but left his food untouched.	untouched
18.	The king lived in a castle.	castle
19.	The boy looked out the window.	looked
20.	It has started to rain.	started
21.	I cut my finger on a sharp knife.	knife
22.	She was knitting a jumper.	knitting
23.	The beginning of a sentence has a capital letter.	beginning
24.	I have already been asked to the party.	asked
25.	The mechanic used his wrench on the car wheel.	wrench
26.	Some African tribes live in the jungle.	tribes
27.	I would like to read that book.	read
28.	The cook was needed in the kitchen.	needed
29.	There was plenty of material to make two dresses.	material
30.	I can imagine what a witch looks like.	imagine
31.	Mum told me not to climb up the tree.	climb
32.	I saw a rainbow in the sky.	rainbow
33.	The day was cloudy and dull.	dull
34.	The man was releasing all the pigeons from their cages.	releasing
35.	There was a notice forbidding people to smoke.	forbidding
36.	The car that had hit the tree was a total wreck.	wreck
37.	I saw him running across the playground.	running
38.	There was a horrible monster in the picture.	horrible
39.	He wheeled the barrow down the path.	barrow
40.	There was a thistle growing in the paddock.	thistle
41.	She kept the biscuits in the cupboard.	kept
42.	They were watching Dr. Who on TV.	watching
43.	He held up the picture for everyone to see.	held

* Silent letter words and sentences are underlined.

LIST IIA

1.	Some men were digging up the road.	men
2.	I can jump very high.	very
3.	The fur coat cost a lot of money.	cost
4.	There was so much rain everything was flooded.	rain
5.	Children begin school when they are five.	begin
6.	She ate every scrap of her dinner.	every
7.	He was clicking his fingers in time to the music.	clicking
8.	He was walking slowly up the hill.	walking
9.	A funny thing happened on the way to school.	thing
10.	She was clipping back the bush which had grown too big.	clipping
11.	A helicopter rescued the mountain climber.	climber
12.	The newspaper was delivered in the morning.	newspaper
13.	The girl was playing the pin ball machine.	machine
14.	Someone was knocking at the door.	someone
15.	The bomb completely destroyed the building.	destroyed
16.	The man dealt the cards to all the players.	dealt
17.	If you poke a pin into your finger it may hurt.	poke
18.	The sums were not too hard after I got the knack of doing them.	knack
19.	I sprained my wrist playing basketball.	wrist
20.	2, 4, 6 and 8 are even numbers.	even
21.	We couldn't see anyone we knew.	anyone
22.	He teased his little sister until she cried.	teased
23.	They had moved to a new house a month ago.	moved
24.	There is always a clown in the circus.	circus
25.	She put the clay in water to soften it.	soften
26.	She was using a hammer to hit the nail.	using
27.	The cat gave birth to five kittens.	birth
28.	I sat next to Mum in the pictures.	next
29.	We go home from school in the afternoon.	afternoon
30.	When the teacher left the room there was chaos.	chaos
31.	They left home without noticing that it looked as if it was going to rain.	noticing
32.	She suggested that we should go to the pictures.	suggested
33.	A tomb is where people are buried.	tomb
34.	She took the leaves away in the wheelbarrow.	wheelbarrow
35.	There are 14 million people in Australia.	people
36.	He was feeling sick.	feeling
37.	A lamb is a baby sheep.	lamb
38.	The house was rebuilt after the fire.	rebuilt
39.	The loud knock on the door gave me a fright.	knock
40.	A worm will wriggle when you pick it up.	wriggle
41.	People think money brings prestige.	prestige
42.	The floor boards in the old house were creaking.	creaking
43.	She blinked her eyes in the strong light.	blinked

LIST IIIA

1.	Robin Hood had a bow and arrow.	bow
2.	I was late but there were still some tickets left.	some
3.	He caught the train to work each day.	day
4.	You can often see the moon at night.	moon
5.	We invited everyone we knew to the party.	everyone
6.	I like to eat ice-cream.	like
7.	His mouth was wide open.	wide
8.	There wasn't anything left for the last person.	anything
9.	She had trouble tying her shoe laces.	tying
10.	The tribesmen hunted the man eating tiger.	tribesmen
11.	Trees that don't lose their leaves are evergreen.	evergreen
12.	She told him to be quiet three times.	times
13.	All his money amounted to five dollars.	amounted
14.	People whose kidneys don't work often need a machine to help them.	kidneys
15.	The man was exceedingly cross when the truck squashed his car.	exceedingly
16.	All the news on TV was bad.	news
17.	I must go because it's getting late.	getting
18.	I hurt my knee when I fell down.	knee
19.	The train set was electrically operated.	electrically
20.	He answered the question correctly.	answered
21.	All the sandwiches were consumed very quickly.	consumed
22.	The girl had enough money to buy three hamburgers.	money
23.	There was a bowl full of strawberries on the table.	bowl
24.	A person who can't speak at all is dumb.	dumb
25.	She got her revenge by beating him in the next game.	revenge
26.	He was called John.	called
27.	We had a trip on the scenic railway.	scenic
28.	We take risks if we cross the road without looking.	risks
29.	I did not know the meaning of the word.	meaning
30.	I used tracing paper to copy the picture.	tracing
31.	The boy was feeling sick so he went home.	sick
32.	All the cars halted at the lights.	halted
33.	The chop had a lot of gristle on it.	gristle
34.	There were three people in the car.	three
35.	The cake was so good I didn't leave a crumb.	crumb
36.	The boy rapped his knuckle on the table.	knuckle
37.	The trucks were carrying stones from the quarry.	quarry
38.	The wheel fell off his bicycle.	wheel
39.	You have four fingers and a thumb on each hand.	thumb
40.	The umpire blew his whistle.	whistle
41.	Dad was making dinner when I got home.	making
42.	She ran very quickly.	quickly

APPENDIX II

Year Level and Spelling Performance

Year 2		Year 3		Year 4	
Rank Order Correct	Number Correct	Rank Order Correct	Number Correct	Rank Order Correct	Number Correct
lamb	41	lamb	80	lamb	99
knee	37	knee	78	knee	99
thumb	28	knife	73	knife	95
climb	26	thumb	69	climb	94
knife	23	climb	67	thumb	89
knock	21	crumb	55	knock	84
crumb	20	castle	53	castle	78
castle	11	knock	49	crumb	69
thistle	7	whistle	39	whistle	66
whistle	6	thistle	33	dumb	61
wrist	6	dumb	32	thistle	54
dumb	5	knitting	32	wrist	53
knitting	4	wrist	29	knitting	50
wriggle	4	wriggle	28	wriggle	45
wreck	4	wreck	20	knack	37
knack	3	gristle	17	knuckle	37
gristle	3	knack	14	wreck	35
wrench	3	wrench	14	wrench	30
knuckle	2	knuckle	13	gristle	29
tomb	0	tomb	11	tomb	22

APPENDIX III

Ability Group and Spelling Performance

Group 1: Low Spelling Ability (N=119)		Group 2: Medium Spelling Ability (N=122)		Group 3: High Spelling Ability (N=119)	
Rank Order Correct	Percentage Correct	Rank Order Correct	Percentage Correct	Rank Order Correct	Percentage Correct
lamb	16.0	lamb	68.9	knee	98.3
knee	13.4	knee	66.4	lamb	98.3
knife	10.1	climb	57.4	knife	92.4
thumb	8.4	knife	56.6	climb	92.4
climb	5.9	thumb	54.9	thumb	91.6
knock	4.2	knock	38.5	castle	86.6
crumb	4.2	crumb	32.8	knock	85.7
castle	3.4	castle	28.7	crumb	83.2
dumb	2.5	dumb	18.9	whistle	74.8
tomb	1.7	whistle	18.0	wrist	62.2
knitting	1.7	knitting	17.2	thistle	61.3
knack	0.8	thistle	16.4	dumb	60.5
thistle	0.8	wriggle	12.3	knitting	52.9
whistle	0	wrist	11.5	wriggle	52.1
wriggle	0	gristle	10.7	wreck	46.2
wrist	0	knack	7.4	knuckle	39.5
gristle	0	knuckle	4.1	knack	37.0
knuckle	0	wrench	4.1	wrench	35.3
wrench	0	wreck	3.3	gristle	30.3
wreck	0	tomb	3.3	tomb	22.7

APPENDIX IV

Language Background and Spelling Performance

Rank Order based on Frequency Measure	Bilingual Group (N=81) Percentage Correct	Number Correct	Monolingual Group (N=279) Percentage Correct	Number Correct
knife	45.7	(37)	55.2	(154)
climb	37.0	(30)	56.3	(157)
castle	30.9	(25)	41.9	(117)
whistle	19.8	(16)	34.1	(95)
thumb	37.0	(30)	55.9	(156)
knee	51.9	(42)	61.6	(172)
knock	37.0	(30)	44.4	(124)
lamb	55.6	(45)	62.7	(175)
wreck	12.3	(10)	17.6	(49)
wrist	18.5	(15)	26.2	(73)
dumb	13.6	(11)	31.2	(87)
tomb	6.2	(5)	10.0	(28)
knitting	17.3	(14)	25.8	(72)
wrench	8.6	(7)	14.3	(40)
knack	12.3	(10)	15.8	(44)
thistle	13.6	(11)	29.7	(83)
knuckle	7.4	(6)	16.5	(46)
wriggle	11.1	(9)	24.4	(68)
crumb	32.1	(26)	42.3	(118)
gristle	9.9	(8)	14.7	(41)

APPENDIX V

Frequency Ranking* and Spelling Performance

Silent letter Words Rank Ordered 1-20		Frequency	Number Correct Year Level 2	3	4
1.	knife	(1,400-1,500)	23	73	95
2.	climb	(1,600-1,700)	26	67	94
3.	castle	(2,400-2,500)	11	53	78
4.	whistle	(2,700-2,800)	6	39	66
5.	thumb	(2,800-2,900)	28	69	89
6.	knee	(3,900-4,000)	37	78	99
7.	knock	(4,200-4,300)	21	49	84
8.	lamb	(4,300-4,400)	41	80	99
9.	wreck	(4,700-4,800)	4	20	35
10.	wrist	(5,000-5,100)	6	29	53
11.	dumb	(7,300-7,400)	5	32	61
12.	tomb	(8,900-9,000)	0	11	22
13.	knitting	(9,200-9,300)	4	32	50
14.	wrench	(13,000-13,100)	3	14	30
15.	knack	(18,000-18,100)	3	14	37
16.	thistle	(22,500-22,600)	7	33	54
17.	knuckle	(23,400-23,500)	2	13	37
18.	wriggle	(24,900-25,000)	4	28	45
19.	crumb	(25,100-25,200)	20	55	69
20.	gristle	(84,700-84,800)	3	17	29

* Frequency order as presented in The American Heritage Word Frequency Book, Carroll et al. (1971).

APPENDIX VI

Error Analysis Coding Classifications

Code	Classification
1.	Word spelled correctly
2.	An obvious attempt at the word but incorrect. Silent letter included in the attempt.
3.	An obvious attempt at the word but incorrect. No silent letter included in the attempt.
4.	An unclassifiable error. No attempt at the word. The spelling of another word from the sentence.

Examples of children's spelling of target word using code classification 1 to 4

1 Correct spelling	2 Silent letter included in incorrect attempt	3 No silent letter included in incorrect attempt	4 Unclassifiable attempt
knee	kne kney	nee ne niyy neek	new
knife	knif knink knofe	nife nifot	
knock	koickt koc	nock	rook vogge
knack	knak	nack nace neck nate	ndk
knitting	kniting kitten knniting kniteing	niting nitting	nen nin
knuckle	knakle kuchl	nacl nuccl nukel	naru
wreck	wreak	regg reak rece reck	
wrist	wirst	rist resk rict rissed	reto r_
wrench		riss rensh rench reach	

Examples of children's spelling of target word using code classification 1 to 4

1 Correct spelling	2 Silent letter included in incorrect attempt	3 No silent letter included in incorrect attempt	4 Unclassifiable attempt
wriggle	wetk rigw	rigl rickle	right
castle	caslte castal castiol	casll kasll kasel	king crchc
whistle	wistle whstall whithe	wisslle wisll wsl	
gristle	grirstle	gris grisel gsslly	gride
thistle	thithel	tissll fisl thisll	fi tuting
climb	climeb clob ckimb cimb clibm	cllom kom clime	kiol kon cine cithstu
lamb	lameb	lamme lame	lnt lier bapstn nam
thumb	thube tumb thunb	thumy fum fumme	thf fwewhe fun fiter
crumb	cramb crub	cramm crum grum	arm craft rcae htum
dumb	damb	dome dum danmme dume dom	bun banm nuder bolte
tomb	toob tumb tob	toom tom tume toem twom torm	toinestir lohom theton chime tdoon

APPENDIX VII

Comparison of Percent Correct, and Percent Incorrect but Including Relevant Silent Consonant in Pairs of Words Similar in Length and Frequency, Tabulated by Year Level

Spelling Word with relevant Silent Consonant underlined		Percentage Correct			Percentage including relevant silent consonant		
		Year Level			Year Level		
		2	3	4	2	3	4
	Frequency						
knife	(1,400-1,500)	19.2	60.8	79.2	25.8	20.0	8.3
climb	(1,600-1,700)	21.7	55.8	78.3	1.7	5.8	2.5
wriggle	(24,900-25,000)	3.3	23.3	37.5	8.3	15.0	13.3
thistle	(22,500-22,600)	5.8	27.5	45.0	0.8	5.8	5.8